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File Code: 3410
Date: August 1, 2000

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At your request, Mary Lou Fairweather, Plant Pathologist, met with Jennifer Allen, Grand Canyon National Park Hazard Tree Coordinator, to view and discuss any hazard tree concerns related to the aftermath of the Outlet Fire. They also reviewed the history of hazard tree surveys in the administrative and commercial property areas on the North Rim and spent time demonstrating survey techniques. This letter is a follow-up to their visit.

The Burned Area Emergency Rehabilitation (BAER) plan for the Outlet fire states, "All trees standing within falling distance of public use areas and which could pose a hazard to the public or damage property will be periodically and systematically inventoried." Mary Lou and Jennifer surveyed many public access areas affected by the fire including: Fuller Canyon Road and the picnic areas along this road; Point Imperial parking area; Point Imperial trail; Ken Patrick Trail; Widforss trail; Forest Road 610; and Saddle Mountain Trail. Drive-by or windshield surveys were used along roads. In parking areas and along trails, trees were visually scanned for hazards and potential flaws while walking through an area.

The only observed defect in trees created by the Outlet fire was death. Areas having a great abundance of mortality include sections of Fuller Canyon Road, the second picnic area, and Point Imperial Trail. Along Fuller Canyon Road, there are a few areas with many dead and sometimes large trees adjacent to the road. The second picnic area has one tree that may live, the rest are dead. Point Imperial Trail has an extensive area of severely burned large diameter standing dead trees. Across the Outlet fire area, a number of severely burned trees, which survived the fire, are expected to die over the next 3 to 4 years.

Once a tree is dead, decay processes degrade the structural integrity of trees quickly. The primary agents causing deterioration are fungi and insects, with a succession of types and species changing from year to year until no sound wood remains. In fire-killed trees, the process starts just under the bark and progresses rather uniformly toward the pith. Kimmey conducted a study in California forests with similar tree species composition to the forests in the Outlet fire area. He found that in general, most activity during the first year is from blue stain and incipient decay and results in very little structural degradation[1]. By the end of the second year, degradation of the sapwood can be complete, but depends largely upon the thickness of sapwood, tree species, and tree size. By the end of the third year, practically no sapwood is sound, especially in smaller

[1] Kimmey, J.W. 1955. Rate of deterioration of fire-killed timber in California. USDA Forest Service, California Forest and Range Experiment Station, Circular No. 962. 22 pp.

trees and the tops of larger trees. The outer heartwood also has appreciable deterioration in some trees.

As mentioned above, the rate of deterioration is influenced by tree species. White fir trees killed by fire are shown to deteriorate faster than other species studied. By the end of the second year, approximately 50 percent of gross board-foot volume deterioration is observed. In comparison, deterioration of ponderosa pines and Douglas-firs after two years averages approximately 30 and 20 percent, respectively.

How do these deterioration rates equate with rates of fall of fire-killed trees? Kimmey found that during the first 2 years after a fire there is little noticeable change in the general appearance of fire-killed timber stands. Mary Lou has observed similar behavior in fire-killed ponderosa pines in Northern Arizona. Branches and twigs drop in heavy storms, dead foliage falls, and some loose bark is evident in the tops of small trees. In the third year, evidence that the stand is breaking up becomes clear. Some smaller trees (10 to 12 inches in diameter) of species with thick sapwood like white fir break off at various heights from the ground. The outer ends of smaller branches break and fall, thin bark becomes loose on small trees and in the tops of larger trees, and some bark drops off.

In the fourth and fifth years, many ponderosa pines and white firs of small size break off at ground level or up to 50 or more feet above the ground. Even some of the larger trees of these species and smaller trees of Douglas-fir will break off by the fifth year. After the fifth year, the general breakup continues until only scattered barkless snags and stubs remain. The last remnants of a stand are short stubs of the largest Douglas-firs.

Some exceptions to this general pattern of breakup occur at high elevation and on dry sites where decay in the upper bole is arrested by drying. Fungi are active only near the base of the tree, where moisture from the ground is sufficient to permit decay. Dead trees then rot off at or near the ground and drop full length, rather than piece by piece from the top. Therefore, where moisture limits decay, the larger and thicker barked trees may be among the first to drop, and the smaller, thin-barked trees may be the surviving remnants of the stand.

Knowing that fire-killed trees **will** eventually fall and the level of risk to a target depends on the use of an area and whether or not a target is present at any given time, Mary Lou and Jennifer discussed the following options for managing hazard trees within the Outlet fire area:

Roads:

(1) No action.
(2) Cut all dead trees that are likely to fall on road.
(3) Cut large (> 12 inches in diameter at breast height (dbh)) dead trees that are likely to fall on road.
(4) Close road during periods of high wind.

Picnic Areas:

(1) No action.
(2) Cut all dead trees that have likelihood of hitting the picnic or parking area.
(3) Cut all dead trees likely to fall on picnic/parking area and install shade structures.
(4) Close the second picnic area indefinitely until all fire-killed trees have fallen.
(5) Relocate second picnic area.

Hiking Trails:

(1) No action.
(2) Cut all dead trees with likelihood of falling on trails.
(3) Close trails during periods of high wind (mid-May through June).
(4) Reroute trails around severe burn.
(5) Close trails indefinitely, until most dead trees have fallen.
(6) Point Imperial trail is in proposed wilderness and is treated as wilderness. Check on signage for "at your own risk" type warnings in wilderness areas.

This partial list of options does not include the input of your local land managers and is meant to offer some assistance in their decision making process. The fact that the North Rim is closed from mid-October until mid-May certainly decreases the odds of dead trees hitting a target. However, northern Arizona does experience high winds from mid-May through June when the park is open, and a lot of downfall of fire-killed trees can be expected to occur during this time within the next 4 years.

Mary Lou is available for further assistance if you would like her input. Please do not hesitate to call if you have any questions (520) 556-2075.

/s/
John Anhold
Arizona Zone Leader of
Entomology and Pathology

Cc:
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